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A

VIEW OF THE HEAVENS,

OR

FAMILIAR LESSONS

ON

Astronomy:

WITH A

CELESTIAL MAP,

BY WHICH THE CONSTELLATIONS CAN BE EASILY FOUND,

ADAPTED TO THE USE OF SCHOOLS.

BY REV. AMOS PETTENGILL,

PASTOR OF THE CHURCH AT SALEM BRIDGE, CONN.

O Lord, how manifold are thy works! In wisdom hast thou made them all.—DAVID.

NEW-HAVEN:

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DISTRICT OF CONNECTICUT, SS.

BE IT REMEMBERED, That on the tenth day of October, in the fiftieth year of the Independence of the United States of America, AMOS PETTENGILL, of the said District, hath deposited in this office the title of a Book, the right whereof he claims as Author in the words following, to wit: "A View of the Heavens, or familiar lessons on Astronomy; with a Celestial Map, by which the Constellations can be easily found. Adapted to the use of Schools. By Rev. Amos Pettengill, Pastor of the Church at Salem Bridge, Conn. O Lord, how manifold are thy works! In wisdom hast thou made them all —*David.*"

In conformity to the act of Congress of the United States, entitled, "An act for the encouragement of learning, by securing the copies of Maps, Charts and Books, to the authors and proprietors of such copies, during the times therein mentioned." And also to the act, entitled, "An act supplementary to an act, entitled 'An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

CHAS. A. INGERSOLL,
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A true copy of Record, examined and sealed by me,
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PREFACE.

MANY valuable Treatises on Astronomy have been published, and laudable efforts made to disseminate the knowledge of this important subject. But a great proportion of the community still remain uninformed. They annually purchase an Almanack, and receive some assistance from it; but much of it is unintelligible to them, and of course uninteresting and useless. Being in a measure precluded from the means of instruction, they imagine themselves to be incapable of understanding this science, and take it for granted that they are inevitably doomed to remain in the dark. This impression leads them to treat the subject with indifference. Their indifference would be less lamentable, were it not attended with erroneous views, and superstitious notions, which tend to weaken and contract the mind.

This evil cannot be removed at once ; but it may be gradually prevented. It is not necessary for this purpose, that the rising generation should all become extensively acquainted with Astronomy ; but it is necessary that they should understand the first principles of this science. Newton, Herschel, and other eminent Astronomers have so prepared the way, that any person of ordinary abilities, may soon acquire this knowledge. He cannot demonstrate the laws by which the heavenly bodies move, without the knowledge of Mathematics ; but he can find the Planets and constellations, and know what discoveries others have made. He can so extend his views, as to be able to see, and explain the reason of those occurrences, which, by many, are deemed unaccountable and ominous. He can do this without extensive reading and study, and without relinquishing his ordinary employments. But he cannot do it without thinking. His mind must be active—his attention fixed, and suitably directed.

Astronomy is eminently calculated to call into vigorous exercise, the noblest powers of the mind, so as to exclude low and debasing thoughts. It is suited to excite, and gratify the curiosity of the young—to turn away their eyes from beholding vanity—to extinguish their unhallowed desires, and thus to prevent them from disturbing others, and destroying themselves.

If they can be induced to view the starry heavens with sufficient attention to learn some of the Constellations, they will acquire a lively interest in the subject, and pursue it with delight. This will prepare, and dispose them to extend their acquaintance with the science, which is so peculiarly adapted to enlarge and elevate their minds. To encourage and aid them in this delightful employment, this Map of the heavens was planned; after fruitless attempts had long been made to induce some other person to undertake it. It was intended to be a substitute for Celestial Globes, which are too expensive and unwieldly for common use. By the suggestions

and advice of several literary gentlemen, this Treatise was added. This was intended to embrace nearly all the first principles of Astronomy, and to discuss them so familiarly, as that all might understand it, and so concisely as that none might be discouraged from reading it. Several additions have been made since the recommendations were received ; but none which affect the positions it first contained.

It has been carefully corrected according to the most approved authorities, and the critical remarks of many scientific men, to whom it has been exhibited. But still it will doubtless need emendation. Any intimations, which may contribute to its improvement, will be thankfully received.

INTRODUCTION.

It is not the design of the Bible to explain the laws of nature; but to teach us what we must do to be saved. It frequently alludes to the natural heavens, and speaks of them according to their appearance, and leaves us to extend our acquaintance with them by such means as Providence affords us.

Whether the history of creation, which the Bible gives, relates to the fixed stars, or only to the solar system is not certain. But it is certain, that *He who built all things is God.** *By his Spirit he hath garnished the heavens.*†

It is his work that now claims your attention. The stars, toward which he directed Abraham to look, that he might realize his inability to number them, are presented to your view. The same Constellations that ancient saints and prophets observed, continue to make their appearance; and to call on us, as they pass, to *seek him, that maketh the seven stars and Orion.*‡ You often see

* Heb. iii. 4. † Job xxvi. 13. ‡ Amos v. 8.

the same moon and stars that excited devotion in the heart of the Psalmist. The heavens still declare the glory of God, and the firmament showeth his handy work.*

While we contemplate his power, wisdom and goodness, as they are manifested through the visible creation, let us fear and adore his great name; and commit the keeping of our souls to him in well-doing, as to a faithful Creator.

* Psalm xix. 1.

LESSON I.

THE EARTH.

He stretcheth out the north over the empty place, and hangeth the earth upon nothing.—Job xxvi, 7.

The earth is suspended in empty space, with nothing to support it, but the power of God. It is found to be a great globe or ball; for

1. The shadow of it appears round on the moon, when eclipsed.

2. Many persons have sailed round it.

3. The highest part of a ship at sea is seen first.

4. As you travel north the sun and stars move toward the south, and as you travel south they move toward the north. This must be owing to the convexity of the earth; for a million of miles, on a horizontal plane, would occasion no variation in the appearance of the fixed stars; and but very little in that of the sun.

5. The north pole becomes elevated as you travel north, which would not be the case if the earth were not round

Mountains and vallies are so small in comparison with the earth, that they do not materially affect its shape.

The earth is a little flatted at its north and south ends. It ought to extend seventeen miles farther each way, to be entirely round.

Should you continue to travel in any direction you would come round the earth to this place again, and see the heavens over your head all the way. Toward them is *upward*, and toward the earth is *downward* in every place. For God has established a law, called the *attraction of gravitation*, by which every thing on and near the earth, is drawn toward its centre. This is the reason that material substances have weight. They are light or heavy according to the force by which they are attracted. If you throw a stone into the air, it will return because it is drawn back. This mysterious law, which operates uniformly in every place and on every particle of matter, is calculated to remind us of the immediate presence, power and goodness of God.

QUESTIONS.

What supports the earth?
What is the shape of the earth?
How does it appear that the earth is nearly round?
Why is toward the earth *downward*, and from the earth *upward* in every place?
What is that law called, by which every thing on or near the earth is drawn toward its centre?
Of what is this law calculated to remind us?

N. B. For the explanation of terms relating to Astronomy look to the Glossary at the end of this book.

LESSON II.

THE DAILY REVOLUTION OF THE EARTH.

While the earth remaineth, seed time and harvest, and cold and heat, and summer and winter, and day and night, shall not cease.—Genesis viii. 22.

In this lesson your attention is called to the way in which God accomplishes his promise, respecting day and night. He does this by a general law, as he does every thing else, relating to the material universe.

When he made the earth he caused it to roll round toward the east once in twenty-four hours; and it has continued to roll in the same manner ever since. You do not perceive that it moves, because you partake of its motion. Were you to sail ever so rapidly on smooth water, you would not be conscious of moving. You might walk across the boat, and step into another boat that had the same motion; or throw articles into it, or into the air, and all would seem as if you were at rest. But objects really at rest would appear to move in a direction contrary to that in which you were sailing. There are no objects around us, but what have the same motion with the earth, except the sun, moon and stars. These seem to move toward the west. It is absurd to suppose that they really do thus move. For such is their distance, that the sun must move more than six thousand miles, and the fixed stars many

millions of miles every second, in order to perform a revolution round the earth in twenty-four hours; and they must do this without any known law, and even contrary to the known laws of nature.

Twilight is the reflection and the refraction of the sun's rays from the upper part of the atmosphere.

QUESTIONS.

How does God cause the succession of day and night?
Why do you not perceive the motion of the earth?
Why do the heavenly bodies appear to move toward the west?
How does it appear that they do not really move this way?
What occasions the twilight?

LESSON III.

THE REVOLUTION OF THE EARTH ROUND THE SUN.

The heavens declare the glory of God.——In them hath he set a tabernacle for the sun.—Psalm xix. 4.

The Sun is a great globe more than a million times larger than the earth. Its light and heat are probably occasioned by the combustion of gass in its atmosphere. It performs a rotation on its axis once in twenty-five days, as appears from the dark spots on its surface; and it is carried round in a small space, because it is at-

tracted by the planets. But it always remains in that part of the heavens, where God at first placed it. Since material bodies attract one another in proportion to their respective nearness and quantities of matter, the Earth attracts the Sun and the Sun much more powerfully attracts the Earth. Hence they would be drawn together, were not the Earth whirled round the Sun in a circle, which is called its Orbit.

Thus the Earth has two motions, like a wheel, rolling round while it moves along. The imaginary line on which it rolls, is its Axis and the ends of the Axis its Poles. Its revolution on its Axis causes day and night; and its revolution in its Orbit causes the seasons of the year. Its Orbit is not a perfect circle; for it is three millions of miles nearer to the Sun in the winter, than it is in the summer.

To illustrate the law by which the Earth moves in its Orbit, hold a ball by a string, and let it receive a stroke which would tend to throw it forward. Instead of taking that course it will revolve round your hand in a circle. If you jerk the string every time it comes round so as to preserve the motion it first received, it will continue to revolve. Your hand represents the Sun, and the ball the Earth. The stroke which the ball received represents the force called the *projectile force*, which God gave the earth at creation. The tendency which the ball has to fly off in every direction, as it whirls round, is the *centrifugal force*. The string, which prevents it, represents the *centripetal force*, or the Sun's

attraction, which holds the Earth during its yearly revolution.

This ball would continue to revolve as the Earth does, without any motion of your hand, were it not retarded by the Earth's attraction. For it is a law of nature that a body at rest will never move, unless something moves it; and that when once moved it will never stop, unless something stops it.

The Earth goes round the Sun in three hundred and sixty-five days and about six hours. These odd hours make a day in four years, which is added to February. When this is done the year is three hundred and sixty-six days long, and is called leap year.

QUESTIONS.

What is the Sun? What is its magnitude? What motions has it? What probably occasions its light and heat?

Does the Sun ever move from one part of the heavens to another?

Why does not the Earth fall to the Sun, or the Sun to the Earth?

What are the Orbit, Axis and Poles of the Earth?

What motions has the Earth?

What are they called, and what do they occasion?

How would you illustrate the yearly revolution?

How the *projectile*, *centrifugal* and *centripetal* forces of the Earth?

Will a body in motion ever stop of itself?

Why is it necessary to move your hand in order to keep a ball whirling round it?

How long is a year?

Why is a day added to February every fourth year?

What is the year then called?

LESSON IV.

THE SEASONS OF THE YEAR.

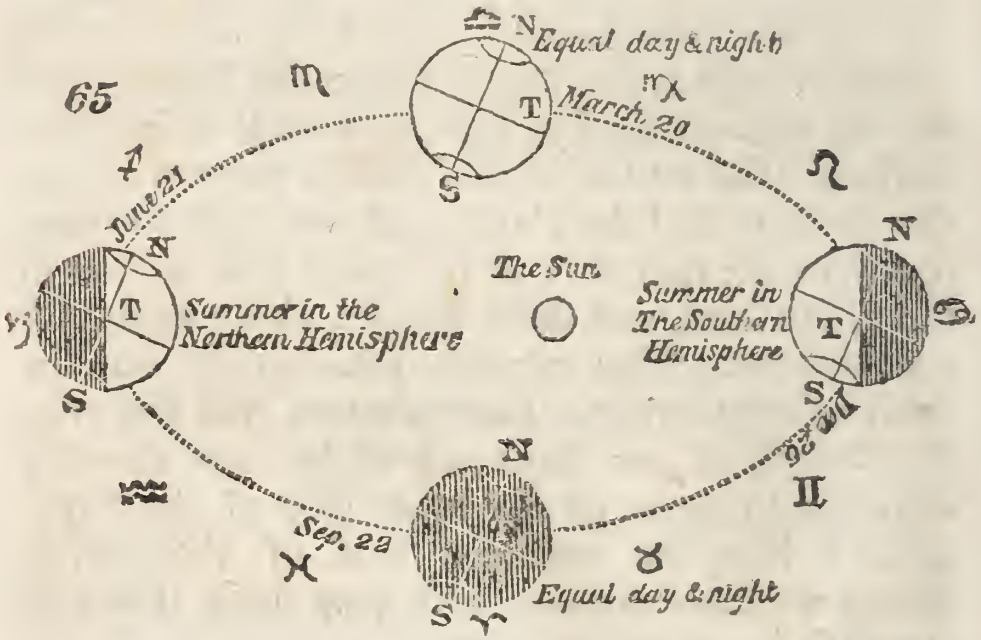
O God, thou hast set all the borders of the earth: thou hast made summer and winter.—Psalm lxxiv. 17.

Twice in a year, the 20th of March and the 23d of September, the Sun crosses the Equinoctial line, (the Equator.) Then the day and night are equal—each twelve hours long, all over the world, except at the Poles, where the Sun is seen by the refraction of its rays when it is below the horizon. But on the 21st of March the sun sets at the south end of the Earth, and does not rise there again for six months; at the same time it rises at the north end, and does not set there again for six months. The reverse takes place on the 24th of September. Our seasons, and the relative length of our days and nights are directly opposite to those on the other side of the Equinoctial line, or southern half of the Earth. When we have summer with long days, it is winter with long nights there.

God makes summer and winter by causing the Earth's Axis to incline toward its Orbit, and the north Pole to point always toward one particular part of the heavens, during the yearly revolution. Near the part toward which it points there is a Star called the Polar Star. Neither the Earth nor the Sun is, in reality, any farther to the north or south at one time than at another.

Illustration.—Let a candle represent the Sun, and a ball the Earth. Run a small rod through the middle of the ball for its axis. Direct the north end toward the Polar Star. Holding it in this position carry it round the candle in a perpendicular circle, and you will see that the light shines half the time on the north end of it, and half the time on the south end; and that at two points in the circle it shines at the same instant on both ends.

Roll the ball round to the east three hundred and sixty-six times, while carrying it round the candle, and you will have likewise an illustration of the Earth's daily revolution. Carry it eastwardly *over* the candle.



In this Figure T is the Earth and N S its axis.

EQUATION OF TIME.

You will see by this experiment why the Earth which rolls round on its axis about four minutes less than twenty-four hours, must roll more than once round every day, in order to

bring the same part toward the Sun. For it continually moves forward in its orbit. But it moves faster one half of the year, than it does the other half; because it is more attracted by the Sun; and then it must turn more, and the time from noon to noon will be longer.

Beside, the axis of the Earth is inclined toward the plane of its orbit. This tends to shorten the natural days from March to June; to lengthen them from June to September; to shorten them from September to December, and to lengthen them from December to March.—From the united operation of these two causes, four days in the year, the Sun and clock are together, viz. about the 14th of April, 16th of June, 31st of August and 24th of December. On all other days the Sun is either faster or slower than the clock. This difference is called *the Equation of time.* The Sun does not vary from twenty-four hours a half of a minute any single day; but by an accumulation of difference it is sometimes as much as sixteen minutes faster or slower than the clock, which uniformly marks that time.

NOTE.—The Earth has its slowest motion in the summer; because it is then at its greatest distance from the Sun. Hence it is eight days longer on this side of the Equator, than on the other.

QUESTIONS.

When does the Sun cross the Equinoctial line?

In what respect are these two days different from all others?

How long is one end of the earth in darkness and the other in the light after these days?

How does the north pole always point?

What is the effect of this?

Does the Sun or Earth ever move toward the north or south?

How would you illustrate the way in which the seasons are produced?

What is Equation of time?

What two causes produce it?

LESSON V.

THE MOON.

He appointeth the Moon for seasons.—Psalm civ. 19.

The Moon is a round body like the Earth, but forty-nine times less. It receives all its light from the Sun. That part of it which is turned toward us is enlightened as far as it is turned toward the Sun. There are however darkish spots on its disk even when it is enlightened. These are occasioned by mountains and valleys, which intercept the Sun's rays. One of these mountains is a mile in height. Several of them are volcanoes.*

* If you understand Geometry, and wish to find the height of a lunar mountain, first ascertain the distance and diameter of the Moon; and when it is half illuminated, observe on its unenlightened part the bright spots, as they first appear. These are produced by the rays passing over the intermediate convex surface, and striking the tops of the mountains. Find the length of the line from

The Moon goes round the Earth every month, and at the same time rolls over so as to present always the same side towards us. It moves with less rapidity in the winter than in the summer. For the Sun, being nearer to it retards its motion. The Orbit in which it moves round the earth is not a circle, but an *ellipse*. That point of it, which is nearest to the Earth, is called Perigee; and that point, which is farthest, is Apogee. The Moon is therefore once in Perigee, and once in Apogee every month. Its monthly course never varies more than 5½ degrees from the Sun's annual course. When full it is in nearly the same direction the Sun was six months before. Half of the time it is on the north side of the Earth's Orbit; and half the time on the south side. Hence it crosses the plane of the Earth's Orbit twice a month, or once in about fourteen days. The points, where it crosses, are called its Nodes. The point, where it crosses from south to north, is its Ascending Node; and where it crosses from north to south its Descending Node. These points move backward or toward the west 1° 38′ a month. That is, the Moon continues to cross farther and farther to the west, so as to perform a great revolution in about nineteen years; when

one of these spots to the line of illumination by the angle it subtends; and from each end of it, draw a line to the Moon's centre; and you will have another right angled triangle, two sides of which and the included angle are known. Hence the other side from the bright spot to the centre of the moon is easily found. From this subtract the Moon's radius, and the remainder is the height of the mountain.

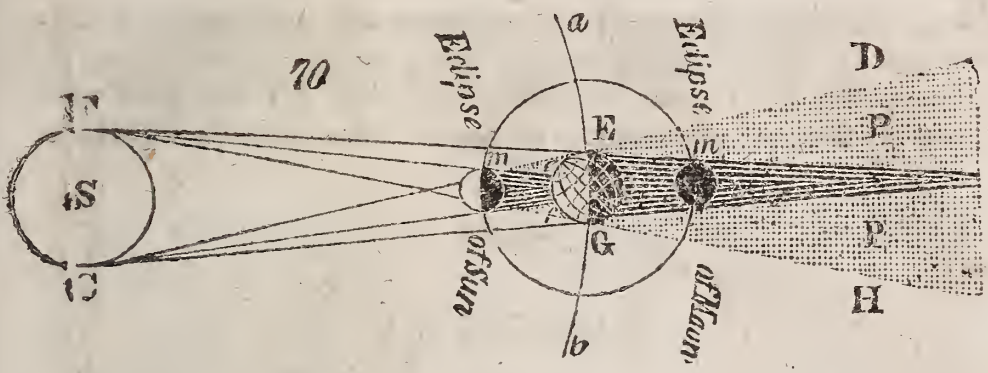
it will again cross where it now does. It is necessary to observe this circumstance in order to calculate

ECLIPSES.

The Moon eclipses the Sun, when it comes between us and the Sun; and it is eclipsed when it passes through the Earth's shadow.

When it changes or is at the full, it is usually too far to the north or south to occasion an Eclipse. But when it changes it will eclipse the Sun, if it is within 16 degrees of a Node; and when at the full it will be eclipsed, if it is within 12 degrees of a Node. If it is at such times exactly in one of its Nodes, the eclipse will be total, or central. When it is in or near its Apogee at the time it centrally eclipses the Sun it produces what is called an annular eclipse. That is, a ring of the Sun will be seen around it. For it is so far off that its disk will appear less than that of the Sun. There can never be more than seven, nor less than two eclipses in a year. The usual number is four.

To illustrate the immediate cause of eclipses suspend a ball to the Sun, and then move your hand round it so as to represent the revolution of the Moon round the Earth. When your hand passes directly between the ball and Sun, the shadow will fall on the ball, and with respect to it the Sun will be eclipsed. When your hand passes to the opposite side it will receive the shadow of the ball, and be eclipsed as the Moon is when the Earth is directly between it and the Sun.



In this Fig. S is the Sun, *m* the Moon, E G the Earth, P the Earth's Penumbra, *a b* a part of the Earth's Orbit. The straight lines are the sun's rays.

NOTE.—If the Moon be in or near its apogee, some of the rays from F and C, will cross one another between her and the Earth, and then the Eclipse of the Sun will be annular.

QUESTIONS.

What is the Moon? What causes it to give light?
What occasions its dark spots? What motions has it?
What is its Perigee? Its Apogee?
How often is it in each of these points?
How long is it on each side of the Earth's Orbit at a time?
How much farther does it go sometimes to the north and south than the Sun ever does?
What are its Nodes? Its Ascending Node?
Its Descending Node? How often is it in a Node?
How long are its Nodes in performing a revolution round the heavens?
Why does it run high when full in the winter?
Why does it run low when full in the summer?
What causes an eclipse of the Sun? Of the Moon?
When does each of these eclipses happen?
Why is there not always an eclipse at the change and full of the Moon?
How will you illustrate the immediate cause of eclipses?

NOTE.—Astronomers have furnished Tables by which any one may learn to calculate Eclipses. But it is not

expedient for persons in ordinary circumstances to attempt it. For the advantage they would derive from it, would by no means compensate them for the time and study, that are necessary to render the process familiar.

LESSON VI.

THE INFLUENCE OF THE MOON.

For the precious things put forth by the Moon.—Deuteronomy xxxiii. 14.

THE HARVEST MOON.

The moon affords us much more light in the *early* evenings of Autumn, than in those of any other season. For then, about the time of its full, it varies only about two hours in the time of its rising for six days together. It is then called the *harvest moon*, because it aids men in gathering their harvest. This circumstance attends the rising of the moon every month, when it is in or near Aries; but it does not rise there when full, except in autumn. When there is the least difference in the time of its rising there is the greatest difference in the time of its setting; and the reverse.

In the long nights of winter the moon continues much longer above the Horizon, near its full, than at other times; because it then passes near where the sun was in the summer.

The goodness of God is thus very conspicuous,

in that he furnishes us with the greatest portion of moonlight, when we need it the most.

TIDES.

As the Moon is only about two hundred and forty thousand miles from us, it attracts the earth with considerable force. Hence it renders all material substances immediately under it lighter than they otherwise would be: For it counteracts the tendency which they have towards the earth's centre. But it produces no sensible effect on solid substances; nor on small collections of water, which have all their parts equally attracted by it at the same time. But on the wide ocean the effect is very perceptible. For there the waters directly under the moon, having their weight diminished by it, are pressed upward by the surrounding heavier waters; just as a piece of wood is, if it be lighter than an equal bulk of the water in which it is immersed. Being thus elevated they roll on till they meet the shore, where they accumulate.

But the Moon's attraction unites with that of the Earth on the opposite side, so as to *increase* the weight of the waters there. Those that are directly opposite to the Moon, being farthest from it, are least attracted by it. Hence they likewise are forced upward by the surrounding heavier waters.* Thus the Moon produces two

* The reason generally assigned for the tide opposite to the Moon is, that the centre of the Earth, being more attracted than the opposite waters, is in a measure drawn from them. Or that these opposite waters rise on ac-

tides at once, which follow it round the Earth. When it is above us we have a tide, and when it is below us we have a tide. They recur once in about twelve and an half hours. For as the Moon continually moves toward the east, it is about twenty-five hours in passing from the meridian to the same meridian again.

In the same way the Sun produces two tides every day. But it is so far off that its tides are very small. When the Moon changes, or is at its full, its tides unite with those of the Sun, and become *spring tides*. At other times the Sun's tides diminish those of the Moon, and produce *neap tides*, when directly contrary to them; as at the first and last quarters of the Moon. For then the Sun tends to produce low water, where the Moon tends to raise it.

There are several causes, which separately tend to raise the tides higher than usual. When two or more of these unite the tides are proportionably increased. Thus if the Moon be in Perigee, when full or new, the tides will be higher than at other times. For it then, being nearer to the Earth, attracts the waters with greater force. The spring tides are the greatest of all about the middle of March and the latter part of September. For then the Sun and Moon, being both near the Equator, unitedly exert a more direct influence in raising the waters; and the in-

count of the centrifugal force they acquire by the revolution of the Earth round a common centre with the Moon. But it seems indisputable, that the effect is partly, at least, produced by the cause stated above.

fluence of the Sun on the waters is greatest, when it is on the south side of the Equator; for it is then nearer to the Earth than it is when on the north side.

THE MOON'S INFLUENCE ON THE WEATHER.

The same causes, which raise tides in the ocean, raise much higher and corresponding tides in the atmosphere. These have a great effect on the weather. The effect would be uniform, so as to produce periodically the same kind of weather, were not the atmosphere subject to changes arising from other causes. God has designedly left us in a state of uncertainty respecting this subject, that we may more sensibly feel our dependence on him. He causes it to rain on one city, and causes it not to rain on another city; by the operation of laws which are hidden from us. But he affords us opportunity of forming probable conjectures concerning the future state of the weather. From the law, by which the tides rise and fall in the atmosphere, many valuable calculations of this kind may be made. For the weather usually changes at *spring and neap* tides. It either storms is cloudy or cold at that time. An equinoctial storm may always be expected, when the Moon is full or new, near the time of the equinoxes; especially if it be at the same time in Perigee. In some seasons the weather is foul at the change, full, and quarters of the Moon; and fair during the interims. The weather has other changes, which

periodically return with the moon. By observing these periodical changes we may calculate what the weather will probably be for many future weeks. But still *clouds without rain* will often disappoint our expectations, and storms will sometimes come without waiting for the Moon.

It is a common remark, that a thunder shower will not come up against the Moon; that it will be either scattered, or carried to the northeast, and arrive from that direction. If this be a fact it is doubtless occasioned by the commotion, which the tide produces in the upper regions. When the Moon runs high it will probably bring a cold breeze from the north.

The Moon affects the sap of vegetables, and perhaps some regard may properly be had to it in gathering the fruits of the earth; but no reason appears, why any regard should be had to it in sowing seed.

THE MOON'S PLACE.

The notion, that the Moon affects different parts of the body according to its place in the heavens, seems to have originated from a harmless contrivance of the ancient astronomers. They divided that part of the heavens through which the Moon passes round the Earth, into twelve equal parts called Signs. They were then led to adopt a device, by which they might readily express and remember the relative situation of these signs. For this purpose they considered

the human body, as divided into twelve parts; each part answering to a particular Sign; the head answering to the first Sign, where they imagined that they saw, in the location of the stars, some resemblance of a Ram's head. Having thus begun, they could easily complete the device, so as to imagine that every Sign contained some resemblance to a corresponding part of the body. Then it would be natural, and convenient in describing the Moon's place to say, that it was in the Head, Neck, and Arms, &c.

This simple contrivance, in the dark ages of the world, prepared the way for a delusion, which has been perpetuated to the present day. Those, who publish Almanacks, encourage it for the sake of rendering their work saleable. Hence they insert a column for the Moon's place, as if it governed successively different parts of the body. But let any person become acquainted with the principles of astronomy, and he will detect this imposition; and look for the Moon's place in the heavens, instead of the Head, Neck, and Arms. He will see that, when according to Modern Almanacks, the Moon governs the Head, it is actually in that part of the heavens, where the ancients supposed it governed the feet,* and that it will not again have the same relative position there, under nineteen years.†

* See Lesson X. Precession of the Equinoxes.

† See Glossary. Cycle of the Moon. As the Moon's Nodes perform a revolution in nineteen years the Harvest Moon continually varies. The difference in the time of its rising is greatest when the *Descending* Node is in Aries,

QUESTIONS.

What circumstance attends the rising of the Moon near its full, in September and October?

Why is it called the harvest Moon?

When is there the greatest difference in the time of the Moon's setting?

Why is the Moon when full longer above the Horizon in winter than in summer?

What occasions the tide in the ocean immediately under the Moon?

What occasions a tide at the same time on the opposite side of the Earth?

What are spring tides? Neap tides?

Why are the tides very high when the Moon changes or is at the full in Perigee?

Why are they the highest of all, near the time of the equinoxes?

Why can we not determine from the tides in the atmosphere what the weather will be?

What changes usually recur in the weather at the change, full, and quarters of the Moon?

What occasions equinoctial storms?

What probably gave rise to the whimsical notion that the Moon successively governs different parts of the body?

LESSON VII.

THE SOLAR SYSTEM.

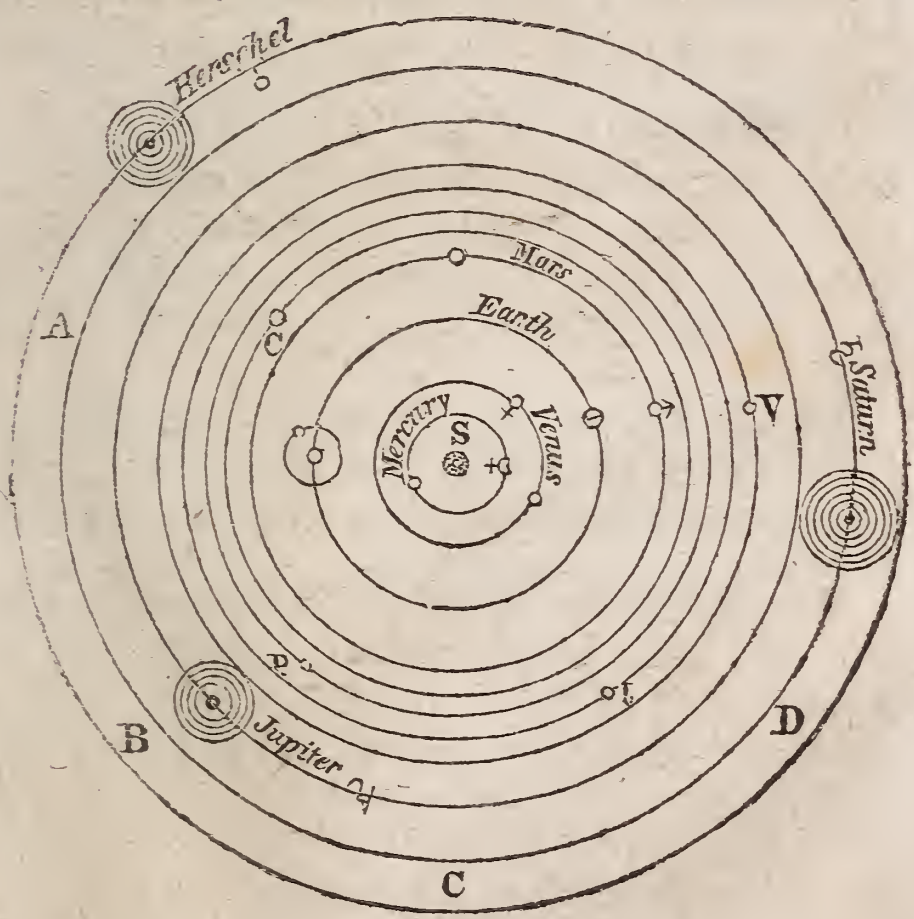
Through faith we understand that the WORLDS *were framed by the Word of God.*—Hebrews xi. 3.

The Solar System includes the SUN, seven

where it will be in A. D. 1830; and the difference is least, and of course the Harvest Moon is the most beneficial, when the *Ascending* Node is in Aries, where it will be in A. D. 1839. The Moon runs unusually high and low once in nine years; for when her Nodes are in the Equinoxes her greatest latitude is directly north and south of the Solstices.

Primary Planets, four Asteroids, eighteen Secondary Planets or Moons, and more than a hundred Comets. The names of the Primary Planets are Mercury, Venus, the Earth, Mars, Jupiter, Saturn and Herschel. The names of the Asteroids are Ceres, Pallas, Juno and Vesta. The Earth has one Moon, Jupiter four, Saturn seven, and Herschel six.

The Sun is in the centre of the System, and these other bodies revolve round it as they are represented in the following Figure.



NOTE.—The small circles round the Earth, Jupiter, Saturn and Herschel, represent the Orbits of their Moons.

Mercury, being the nearest to the Sun, moves round it in a small circle.

Venus revolves in a larger circle, but within the Earth's Orbit.

Mars goes round the Earth's Orbit. Next come at different distances, the

Asteroids, *Ceres*, Pallas, Juno, and Vesta. Then Jupiter, in a still larger Orbit, with four Moons, revolving round it.

Beyond this is the Orbit of Saturn with its seven Moons.

Herschel at a vast distance, with its six Moons. rolls slowly round the Orbits of all the other Planets.

Occasionally a Comet darts through these Orbits, and seems to threaten destruction to the whole system. But directed by the hand of the Almighty, it flies round the Sun; and harmlessly retires again, for ages, into the unknown regions of space.

All the Planets revolve by the same law the Earth does; and most, if not all of them rotate, so as to have day and night, as well as different seasons.

The irregularity of the Comets arises from the fact that their *projective* force was at first disproportioned to their *centripetal* force. It was either too great, or too small, for the purpose of making them revolve in circles. Hence their *centrifugal* force, which is only a modification of the *projectile* force, is continually varying.

ILLUSTRATION.—You may form an idea of the law that governs the Comet by slinging a stone, which being

brought rapidly round your hand, passes off with great velocity. Or by giving a sudden jerk to the string, while whirling a ball, and then letting go. If, while the ball flies off, your hand attracted it, as the Sun does a Comet, it would be gradually retarded, and at length brought back in a curved line, and violently thrown off again in its former course.

The irregularity of the Comets is probably conducive to the order of the Solar System, which is exactly balanced by him, who *framed the worlds.*

QUESTIONS.

What is the Solar System?

What is the order, in which the Planets revolve round the Sun?

What occasions the eccentricity of the Comets?

How would you illustrate the law, by which they are governed?

LESSON VIII.

MAGNITUDES AND DISTANCES OF THE PLANETS.

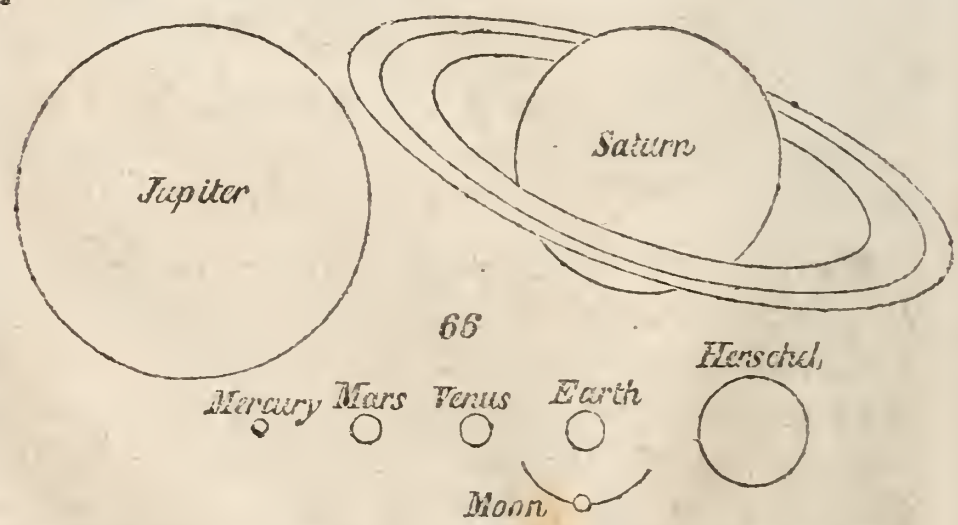
There is one glory of the Sun, and another glory of the Moon, and another glory of the Stars. For one Star differeth from another Star in glory.—1 Cor. xv. 41.

By gradual discoveries astronomers have at length ascertained the diameters of the Planets, their distances from the Sun, the times in which they perform their revolutions, and their hourly motions in their orbits. These may be seen at one view in the following table, expressed in round numbers. You will observe that in this

table the *mean* distance of every Planet is given, or that which is between its greatest and the least distance from the Sun.

Names of the Planets.	*Diameter in miles.*	*Distance from the Sun in millions of miles.*	*Length of the day, or rotation on its axis.*	*Year, or yearly revolution.*	*Hourly motion in its Orbit.* MILES.
Mercury	3,200	37	Unknown.	3 mo's.	111,000
Venus	7,600	68	23 h. 20 m.	7 mo's.	81,000
Earth	7,900	95	24 h.	12 mo's.	68,000
Mars	4,200	144	24 h. 39 m.	23 mo's.	56,000
Ceres	161	266		4 y's.	
Pallas	80	266		4 y's.	
Juno	100	255		5 y's.	
Vesta	238	217		4 y's.	
Jupiter	89,000	492	9 h. 55 m.	12 y's.	30,000
Saturn	79,000	902	10 h. 16 m.	29½ y's.	22,000
Herschel	35,000	1,800	Unknown.	83½ y's.	15,000

This Figure represents the Planets in their true proportions.



NOTE.—The Elipses round Saturn represents his Rings.

By this table and Figure, it appears that Mercury is much smaller than the Earth, and much nearer to the Sun. It is seldom seen, and never far from the Sun. Venus is nearer to the Sun than the Earth is. Hence it is always either a morning or an evening Star. It appears larger than any other Star; but it is not quite as large as the Earth. Mars is still smaller: it has a red fiery appearance; but its apparent magnitude is continually varying. When on this side of its Orbit it is large and bright; but at other times small and dim. The telescope shows that it has snow on its north and south ends, which melts when its summer approaches.—The *Asteroids* are comparatively very small. They can hardly be distinguished by the naked eye.—*Jupiter* is one thousand four hundred times larger than the Earth. It appears almost as large and bright as Venus. Its four Moons cannot be seen without a telescope. By the eclipses of Jupiter's Moons it is ascertained that Light is sixteen and a half minutes in crossing the Earth's Orbit, and eight and a quarter minutes in coming to us from the Sun.—*Saturn* is one thousand times larger than the Earth. It appears bright and redish, but not as large as Jupiter. It is surrounded by two broad flat rings, lying in the same plane. The nearest is thirty-four thousand miles from the Planet, and twenty thousand miles wide. The other is two thousand miles beyond the first, and seven thousand miles wide. But neither these nor its seven Moons can be seen by the naked eye.—*Herschel* is ninety times larger than the Earth.

It can scarcely be seen, except by the telescope. It received its name from Dr. Herschel, who first discovered it.—All the Planets receive their light from the Sun, and shine by reflection.

These huge bodies, which differ from one another so widely, with respect to their magnitudes, distances and motion, roll on in perfect harmony according to the laws, which their Creator first assigned to them. It appears from observation and experiments, that the laws of motion are general and uniform.

If a suitable number of balls were so made, placed, and propelled, as to bear the same relation to one another, in these respects, that those of the Solar System do; they would, of their own accord, for ever revolve in the same order; were they not prevented by the Earth's attraction, or some other extraneous impediment.

QUESTIONS.

How far is the Earth from the Sun?

How much larger than the Earth is Jupiter? Saturn? and Herschel?

What peculiarity has Saturn?

How long is a year in these Planets?

Why do the Planets shine?

Are the laws of motion general?

Why then cannot balls be placed, so as to revolve of their own accord as the Planets do? Or why cannot a machine be made to go by perpetual motion?

LESSON IX.

THE CONCAVE OF HEAVEN.

It is he that sitteth upon the Circle of the Earth, and the inhabitants thereof are as grass-hoppers; that stretcheth out the heavens as a curtain, and spreadeth them out as a tent to dwell in.—Isaiah xl. 22.

The Heavens appear like a great canopy spread over us; or rather like a hollow globe, in the midst of which we are placed, viewing successively the concave surface, while we are rolled round by the daily revolution of the earth.

In order to become acquainted with the heavens, we must consider them as divided into different regions. The grand divisions of them, that are usually made, correspond with those of the Earth.

The *Equator* is an imaginary circle, passing round the Earth, dividing it into northern and southern hemispheres.

The Ecliptic marks the place, over which the Sun seems to pass during the successive seasons of the year. It is the plane of the Earth's Orbit. This and the plane of the Equator are indefinitely extended; so that the Equator and Ecliptic of the Earth, coincide with the Equator and Ecliptic of the heavens: and the Axis and Poles of the Earth are so extended, as to become the Axis and Poles of the heavens. The sensible Horizon is the circle, where the Heavens and Earth seem to meet.

Every circle is divided into three hundred and sixty equal parts, called degrees ; every degree contains sixty minutes; every minute sixty seconds.

Latitude is the distance north or south from the Equator. But the latitude of a heavenly body is reckoned from the *Ecliptic.*

Longitude is the distance east or west from any point. But the Longitude of a heavenly body is the distance *east* from the point, where the Ecliptic cuts the Equator at Aries. (See Map of the Heavens.)

QUESTIONS.

How do the Heavens appear?
How are they considered as divided?
What is the Equator? The Ecliptic?
What Axis and Poles have the Heavens?
What is the Sensible Horizon?
How is every Circle divided?
What is *Latitude?*
How is the Latitude of a Heavenly body reckoned?
What is Longitude?
How is the Longitude of a Heavenly body reckoned?

LESSON X.

CONSTELLATIONS.

Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion? Canst thou bring forth Mazzaroth in his season? Or canst thou guide Arcturus with his sons?*—Job xxxviii. 31.

The Fixed Stars do not change their relative situation like the Planets, but remain perpetually fixed in the same parts of the heavens. Those of them that appear in clusters, are called Constellations; to which the ancients gave such names as were supposed to be descriptive of the spaces they occupy. All the bright stars and nearly all that are visible, are now included in the Constellations which are described in the next Lesson.

Twelve of these Constellations lie on the Ecliptic. Each one of them extends through a twelth part of it, or thirty degrees. That portion of the heavens which includes them is called the Zodiack. TheZodiack likewise includes the Orbit of the Moon and of all the Planets. It is about sixteen degrees wide, or eight degrees on each side of the Ecliptic.

* Mazzaroth is supposed to be the *twelve Signs*. Pleiades, or the Seven Stars, are figuratively represented as maturing the fruits of the earth. This Constellation appeared in the summer evenings, when the book of Job was written. But on account of the Precession of the Equinoxes, it does not appear so early by nearly two months.

The Sun formerly crossed the Equator in th Spring of the year near the Ram, which wa reckoned as the first of these twelve Constella tions; but you see by the Map that the Sun no crosses the Equator thirty degrees west of this It will continue to cross farther west fifty second of a degree every year. This alteration is called the *Precession* of the *Equinoxes*. This period is completed in twenty-five thousand nine hundred and twenty years. Hence if the world continue twenty-three thousand seven hundred and sixty years longer, the Sun will again cross the Equator south of the Ram, where it did two thousand one hundred and sixty years ago. The Precession of the Equinoxes is caused by the accumulation of matter around the Equator, which the sun attracts, when north or south of it, so as to bring the Equator under it twenty and one fourth minutes sooner than it otherwise would.

The Sun apparently passes through all the Constellations of the Zodiack every year. The *daily* revolution makes it seem to go round the heavens once in twenty-four hours. This however does not alter its position with respect to the stars; for they seem to move round with it. But the *yearly* revolution of the earth makes the Sun seem to move slowly towards the east. Or what is the same thing, it makes the Fixed Stars seem to move slowly towards the west to meet the Sun; so that they rise nearly four minutes earlier every night than they did the preceding night; till they rise before sun down, at noon, in the morning, and pass by the Sun, rise before

it; and perform the same revolution over again.

Thus Arcturus and Orion make their appearance, move on towards the west, and are again lost in day light.

ILLUSTRATION.—Walk round a candle or some distant object; and you will perceive that the direction in which you view it, as it respects other objects at rest, is continually changing. Thus as you are carried round the Sun once a year, the direction in which you view it continually varies, with respect to the Fixed Stars.

QUESTIONS.

What are the Constellations?
What do their names denote?
How many of them are on the Ecliptic?
What is that space called which includes these twelve Constellations?
What is the name of that Constellation near which the sun formerly crossed the Equator in the Spring?
Why does it now cross farther west?
How much farther west will it cross every year?
What is this alteration called? What causes it?
How much does it shorten the year?
What makes the stars seem to move westwardly towards the Sun.
How much do they advance in this direction every day?
How can you illustrate this?

LESSON XI.

CONSTELLATIONS CLASSED AND DESCRIBED.

Praise him all ye stars of light.—Psalm cxlviii. 3.

A Catalogue of the Constellations arranged in

Classes. I. Those of the Zodiack. II. Those between the Zodiack and Lat. 48°. N. III. Those that never set as far north as Lat. 42°. IV. Those that are south of the Zodiack. V. Those that never rise as far north as Lat. 42°.

I.

The Ram.
The Bull.
The Twins.
The Crab.
The Lion.
The Virgin.
The Scales.
The Scorpion.
The Archer.
The Goat.
The Water Bearer.
The Fishes.

II.

The Flying Horse.
Andromeda.
Perseus.
Medusa's Head.
The Waggoner.
The Lynx.
The Little Lion.
Berenice's Hair.
Bootes.
The Grey Hound.
The Harp.
The Swan.
The Lizard.
The Eagle.
Antinous.
The Dolphin.
The Arrow.
The Fox and Goose.
The Horse's Head.
The Northern Crown.
The Serpent.
The Serpent Bearer.
Hercules.
The Bull of Poniatowski.
Sobieski's Shield.

III.

The Little Bear.
The Great Bear.
The Cameleopard.
The Dragon.
Cassiopeia's Chair.
Cepheus.

IV.

The Whale.
The River Eridanus.
The Phenix.
Orion.
The Hare.
Noah's Dove.
The Great Dog.
The Little Dog.
The Unicorn.
The Ship Argo.

	V.
The Hydra.	
The Sextant.	
The Mariner's Compass.	The Altar.
The Air Pump.	The Indian.
The Crow.	The Peacock.
The Centaur.	The Bird of Paradise.
The Wolf.	The Camelion.
The Southern Crown.	The Southern Triangle.
The Southern Fish.	The Flying Fish.
The Microscope.	The Sword Fish.
The Sculptor's Shop.	The American Goose.
The Air Pump.	The Water Snake.
The Crane.	The Telescope.

A few obscure Constellations are omitted in this Catalogue. The whole number is eighty. Only forty-eight however were named by the ancients. The rest are what they considered as *unformed stars.*

The most common Latin names are added in the following description of the Constellations.

New stars sometimes appear while others disappear. Many stars which appear single to the naked eye are found to be double when viewed with a telescope. Some of them contain even three or four Stars. Dr. Herschel has discovered seven hundred of this description.

A DESCRIPTION OF THE CONSTELLATIONS.

THE METHOD EXPLAINED.

The dates show the time when the western parts of these Constellations come to the meridian, about 8 o'clock in the evening. The numerical figures which immediately follow their names denote the number of stars they contain according to Flamsted. He has however included several stars which cannot be seen without a telescope. The names in Italic letters stand for sin-

gle stars, or parts of Constellations. The figures placed after them show their magnitudes. Thus, 1st, denotes that the star is of the largest kind. 2d, denotes that it is of the next largest, &c. But stars which are usually considered as belonging to the same order differ very much in their size. *Sirius* is the largest. The *Goat* in Auriga the West Foot and *East Shoulder* of Orion, the *Bull's Eye*, *Vega*, Antares and Arcturus are larger than several others of the first magnitude. Stars of the sixth magnitude can scarcely be seen.

I. CONSTELLATIONS OF THE ZODIACK.

Dec. 21, 8 o'clock, P. M.—The RAM or ARIES 66. His head is about an hour and a half west of the *seven stars*. It has one bright *star* 2d, and a little to the south west are two others very near each other of the 3d and 4th.

Jan. 12.—The BULL, or TAURUS 140. *Bull's Eye* or *Aldebaran*, 1st. The Bull has the *seven stars* or *Pleiades* on his back, and *Hyades* in his face. The *Hyades* are five stars placed in the shape of V, or a harrow; at the end of which is the bright redish star, called the *Bull's Eye*. Some distance east and north east of this are two stars for the *Bull's Horns*. The north *Horn*, 2d, is the largest. *Saturn* is now near the south horn.

Feb. 18.—The TWINS or GEMINI 85. *Castor* 2d and *Pollux* 1st. These two bright stars are about two hours east of the Bull. They are near

each other. *Pollux* is a little to the southeast of *Castor*. They form the heads of the Twins. Their feet are four very small stars in a row at the southwest. Pollux is a double star. Saturn will be near the Twins about 1827.

March 20.—The CRAB OR CANCER 83. It has two small stars with a blur between them resembling a comet; about an hour east of the Twins.

April 20.—The LION or LEO 95. The *Lion's Heart* or *Regulus* 1st. At the northeast of this is the *Lion's Tail* 2d. The Lion is a cluster of bright stars. Jupiter is now near it at the east.

May 23.—The VIRGIN or VIRGO 110. *Virgin's Spike* or *Spica* 1st. The Virgin is east of the Lion. The *Spica* is southeast, a bright star standing alone. Mars however is now near it, and Jupiter will visit it in 1827.

June 21.—The SCALES or LIBRA 51. The *Southern Scale* 2d, is an hour east of *Spica*. The *Northern Scale* is the next bright star northeast.

July 20.—The SCORPION or SCORPIO 44. *Antares* 1st. The Scorpion is a remarkable cluster of bright stars east of the Scales. Its tail extends to the Horizon, and bends around towards the north, into the Milky Way; and ends in two stars that are close together.

Aug. 23.—The ARCHER or SAGITTARIUS 69. This constellation has several stars of the 2d magnitude. It is close to the Milky Way, east of the Scorpion.

Sept. 23.—The GOAT or CAPRICORN 51. Its

Head is a pair of stars 3d, northeast of the Archer; and its *tail* is a similar pair about an hour to the east of its *head.*

Oct. 15.—The WATER BEARER or AQUARIUS 108. His west *shoulder* 3d, is above the tail of the Goat. East of his east *shoulder* 3d, there is a peculiar arrangement of very small stars extending toward the southeast, imagined to be water poured out by him.

Nov. 22.—The FISHES or PISCES 113. The Fishes are two clusters of very small stars lying northeast and southwest of the first bright star west of the Ram. They are supposed to be joined together by the first bright star south of the Ram called the *Fishes' knot* 2d. For a row of small stars extends to this from each Fish.

NOTE.—These Constellations do not arrive to the meridian at 8 o'clock, P. M. so soon by nearly a month as the Signs do to which they gave names. For these signs have moved 30 degrees to the west by the Precession of the Equinoxes. (See map of the heavens.) The Ecliptic passes between the Pleiades and Hyades, the Horns of the Bull the Head and Feet of the Twins, through Regulus and the south scale of Libra, just above Spica, and Antares; and through the Head of Sagittarius.

The ancients divided the stars of the Zodiack into the above named Constellations in the following manner. As one of these stars rose, they set a vessel to receive the water, which slowly dropped from another vessel. The water which was thus obtained by the time the same star rose the next night, they divided into twelve parts, and poured again into the upper vessel. Small vessels each fitted to contain one part were then successively set to receive the dropping water. All the stars, which rose near the Ecliptic while a vessel was thus filling, were considered as belonging to one constellation.—FERGUSON.

II. CONSTELLATIONS BETWEEN THE ZODIACK AND 84° N. LATITUDE.

Nov. 1.—The Flying Horse or Pegasus 89. *Algenib* 2d, *Markab* 2d, *Scheat* 2d, *Andromeda's Head* 2d. These four stars form a great square. *Algenib* is two hours west of the Ram, and between the fishes. It forms a wing of the Horse. *Markab* is westwardly of this. *Scheat* is northward of *Markab*. *Andromeda's Head* is nearest to the North Pole.

Nov. 22.—Andromeda 66. Her Foot is *Almaac* 2d. Her Head is in the square of Pegasus. This constellation has three bright stars in a row with the *breast* of Perseus.

Dec. 15.—The Triangle 16. It is half way between the Ram and the *foot of Andromeda*, which is the third bright star in a row with her *head*. The Fly is east of the Triangle, three stars near one another.

Dec. 20.—Perseus 59. The brightest star 2d nearly north of the *seven stars* is in the breast of Perseus on the Milky Way. His Head is towards the Pole. A little to the southwest of this is *Algol* in Medusa's Head. It is East of Andromeda's *Foot*, and of the same size when full. This star has periodical variations in its size, supposed to be occasioned by its rotation on its axis like our sun. When it presents a side towards us which has dark spots on it, it appears small like a star of the 4th magnitude. It changes from the 2d to the 4th in 3½ hours, and back again in the same time, and retains its full

size only 2 days 14 hours. It passes over head Lat. 42°.

Feb. 2.—The WAGGONER or AURIGA 66. *The Goat* 1st, north of the Bull's Horns. This very bright star passes a little to the north. Lat. 42° The Constellation contains several other bright stars.

Feb. 28.—The LYNX 44. East of Auriga and north of GEMINI. No bright stars.

April 15.—The LITTLE LION or LEO MINOR 53, east of the Lynx and north of the Lion. No bright stars.

May 24.—BERENICE'S HAIR 43. A cluster of very small stars northeast of the Lion, in the shape of a triangle

June 21.—BOOTES or the OX DRIVER 54. *Arcturus* 1st, east of Berenice's Hair. This star is repeatedly mentioned in the Bible.

May 24.—The GREY HOUNDS or ASTERION and CHARA 25. *Charle's Heart* 3d. West of *Arcturus* and north of Berenice's Hair.

Sept. 1.—The HARP or LYRE 22. *Vega* 1st. North of the Archer. It rises in the northeast and passes directly over head Lat. 41° N. Viga viewed through a telescope appears to be double. One of the stars a brilliant white, the other dusky.

Sept. 23.—The SWAN 81. It is a great cross of stars on the Milky Way directly opposite to the Twins on the other side of the Pole and about the same distance from it, and east of Vega. This likewise passes overhead.

Oct. 23.—The LIZARD 16. It is between the Swan and Andromeda.

Sept. 15.—The EAGLE 71. *Athair* 1st. The Eagle is south of the Harp and Swan. Three stars in a row—the brightest in the middle. It is on the Milky Way. Antinous joins it at the south.

Oct. 1.—The DOLPHIN 18. It has four small stars in the shape of a Rhombus or diamond. It is north east of the Eagle, and very near it.

Sept. 15.—The ARROW 18. North of the Eagle. Three small stars in a row, and one near the end of it.

Sept. 15.—The FOX and GOOSE 35. Between the Dolphin, Arrow and Swan.

Oct. 10.—The HORSE'S HEAD, or EQUAULEUS 10. It is between the Dolphin and the Water Bearer.

July 6.—The NORTHERN CROWN, or CORONA BOREALIS 21. It is a cluster of bright stars directly east of *Arcturus* in the form of an oval.

July 15.—The SERPENT 64. Its *Head* is immediately south of the Northern Crown. It is a crooked row of stars bending around toward the east into the Milky Way.

July 23.—The SERPENT BEARER, or SERPENTARIUS 74. He lies north and south of the Serpent. His feet are on the Scorpion. His *Head* 2d, a bright star west of the Eagle, near the end of a branch of the Milky Way, but more to the north.

July 20.—HERCULES 113. His Head 3d, a little to the north west of the Serpent Bearer's Head, his feet extending far toward the North

Pole. The Solar System is said to be advancing toward a point in this Constellation.

Aug. 15.—The BULL of PONIATOWSKI 7. His head contains three or four *stars*, 5th in the end of a branch in the Milky Way, south east of the Serpent Bearer's Head.

Aug. 23.—SOBIESKI'S SHIELD. It is south-east of the Bull of Poniatowski, on the Milky Way.

III. CONSTELLATIONS WHICH NEVER SET AS FAR NORTH AS LAT. 42° BECAUSE THEY ARE WITHIN THAT DISTANCE FROM THE POLE, WHICH IS ELEVATED 42°.

June 21.—The LITTLE BEAR, or URSA MINOR 24. The *Pole Star* 2d, is the last in its tail. It includes that pair of bright stars which are near the Polar star, and of the same size with it.

March 20.—The GREAT BEAR, or URSA MAJOR 87. This includes the *Dipper* 2d. Two of these stars always point to the Pole. The end of the *Dipper* farthest from the Pole is the *Bear's Tail*. His back is toward the Pole.—*Three pairs of stars* in a row form three of his feet. His *nose* 3d, is the same size with the two stars in his fore foot. There are no bright stars between these and the Twins.

Jan. 15.—The CAMELEOPARD 58. *His Head* 6th is between the *Pointers* and the *Pole*. His tail is toward Perseus, and his feet toward Auriga. It is very obscure.

July 20.—The DRAGON 80. His *Head* is a square of four *stars*. The largest of these is 3d.* His *tail* is a crooked row of stars extending around the Little Bear, and ending between the *Dipper* and *Pole* at the Cameleopard's Head.

NOV. 22.—CASSIOPEIA'S CHAIR 55. Directly opposite to the Great Bear on the other side of the Pole. It resembles a chair turned upside down. A new and dazzling star was seen in this constellation for sixteen months about two hundred years ago.

Oct. 10.—CEPHEUS 35. He is included between the Pole, Cassiopeia and the Swan. His *Head*, 2d, is toward the Swan. His name, and that of four adjoining Constellations were designed to perpetuate the memory of an ancient tradition. Medusa could by a look change a person into a stone. Her golden hair was turned into snakes. Perseus, armed with immortal powers, cut off her head, and performed exploits with it. He also delivered Andromeda from a rock, to which she was bound to be devoured by a monster for her mother Cassiopeia's pride. He then married her. Cepheus, a king of Ethiopia, and one of the Argonauts was her father.

IV. CONSTELLATIONS SOUTH OF THE ZODIACK.

NOV. 22.—The WHALE 97. *Menkar* 2d.—South of the Ram and Fishes. It includes the

* By the variation of this star Dr. Bradley proved that the Earth has an annual revolution, and light a progressive motion.

Fishes' knot. This constellation is very extensive. The bright star in the Whale's Head is on a line with the seven stars and the Goat. Its Tail 2d, is south west on a line with its Head and the Bull's eye.

Dec. 21.—The River Eridanus 84. East of the Whale. It is a crooked tract of small stars extending below the Horizon.

Nov. 22.—The Phenix 13. On the Horizon south of the Whale. A bright star in his head is seen near the Horizon.

Feb. 12.—Orion 78. *Betelguese* 1st. A great square of four bright stars south east of the *seven stars and Bull's eye.* The two highest stars in the square are his shoulders. The two lowest are his feet. His Belt is that remarkable row of three stars called by some the *Yard and Ell* 2d. The three smaller stars, which seem to hang from his Belt, are his *Sword.* His east *shoulder* is in a row with the Bull's horns. In his Sword there is a bright spot said to be larger than the whole Solar System. "It looks like a gap in the sky through which one may see a part of a much brighter region, where there seems to be perpetual and uninterrupted day among numberless worlds, which no human art can discover.—*Ferguson.*

Feb. 20.—The Hare 19. Immediately under the feet of Orion. Noah's Dove is under this.

March 1.—The Great Dog, or Canis Major 31. It is after the Hare. It includes that great sparkling star called *Sirius* 1st, south east

of Orion. The time when the Sun is north of the Great Dog is called *Dog Days.*

March 5.—The LITTLE DOG 14. *Procyon* 1st. This is the first bright star nearly north of *Sirius.*

Feb. 25.—The UNICORN 31. It lies between the Great and Little Dogs. Its Head is close to the east shoulder of Orion. All its stars are small.

March 20.—The SHIP ARGO 64. *Bright stars* 2d, south east of the Great Dog, half of them are below the Horizon.

March 20.—The HYDRA 60. Its *Head* 3d, is south of the Crab, between *Procyon* and *Regulus;* and its *Heart* 1st, is nearly south of *Regulus.* It extends below *Spica,* to the Scorpion. The Mariner's Compass south of Hydra's Heart, and the Air Pump east of the Compass are small Constellations.

April 20.—The SEXTANT 41. Small stars between the *Heart* of Hydra and *Regulus.*

May 23.—The CROW 9. A square of four bright stars west of *Spica,* but more to the south. It is on the back of Hydra. The CUP is west of this. The CENTAUR south east of the Crow, and the WOLF east of the Centaur are on the Horizon and partly below it. The Southern Crown is under Sagittarius.

Nov. 1.—The SOUTHERN FISH 24. *Formathaut* 1st, a pale solitary star. It is west of the whale and south of Pegasus. A straight line from the Dolphin to this star passes between the shoulders and through the whole length of the Water Bearer.

Sept. 20.—The Microscope 10, is half way between the Southern Fish and the Southern Crown.

Oct. 10.—The Crane 13. South of Aquarius, and partly below the Horizon.

Note.—Most of these Constellations will be found on the Map.

It is to be lamented that the Constellations have not received names more suited to their grandeur, and to excite devotional feelings; but you will remember that they were given merely to assist the memory; that they are in no sense descriptive of the stars; and but very imperfectly so of the spaces they occupy, and that all these stars of light shine expressly for the purpose of glorifying their Creator.

QUESTIONS.

How many classes of Constellations are there?

How are they distinguished?

What do the dates prefixed to these Constellations denote?

What do the numerical figures placed after their names express?

How are the names of single stars or of parts of the Constellations distinguished?

What do the numerical figures placed after these names in *Italic* show?

What name is given to the *seven* stars in the Bible?

Where are they?

Why do not the Constellations of the Zodiack come to the Meridian as soon as the Signs do to which they gave names?

What method did the Ancients take to divide the stars of the Zodiack into twelve Constellations, equal in extent?

What is there remarkable in the appearance of *Algol*, the chief star in Medusa's Head? Where is this star?

What bright stars pass directly over head?

Where is Arcturus, a star repeatedly mentioned in the Bible?

Why do the Constellations near the Pole never set?

Why do they seem to revolve round the Pole once in twenty-four hours? Where is Orion?

What is there remarkable in Orion's Sword?

Where is Sirius?

What is the time called when the Sun is north of the Great Dog?

Where will you look to see most of the Constellations represented?

If you draw a straight line from the Pole any way, to what point of the Compass will it extend?

Why does a star really north of another appear to be westward of it, when they are at the east of you?

How will the one nearest to the Pole appear, when they are at the westward of you?

In what way can you determine how the stars are really situated, with respect to the points of the Compass?

For what great purpose do all the stars of light continue to shine?

N. B. By the Map of the Heavens you will see why the stars seem to change their relative situations every night. They are all apparently whirled round the Pole. Hence a star really north of another appears west of it, when they are at the east, and east of it when they are at the west; because they are on a line with the Polar Star. A star that appears south of another when rising will appear west of it near the Meridian, and north of it when at the west, because they are on opposite sides of a line drawn to the Polar Star. Thus Algol which is nearly south west of Perseus appears south east of it when they are at the east. To find what is the true relative situation of the stars you must consider that a straight line drawn in any direction from the Polar Star extends toward the south; and that the right hand of this line is east, and the left hand west; imagining yourself to be on the line with your face toward the Pole.

LESSON XII.

THE MAP OF THE HEAVENS.

The works of the Lord are great, sought out of all them that have pleasure therein.—Psalm cxi. 2.

EXPLANATION OF THE CELESTIAL MAP.

This Map represents in one view, all that part of the Heavens, that is seen near Lat. 42° N. The outer circle, being 48° South of the Equator, bounds your prospect at the south. The opposite part of the smallest circle bounds your prospect at the north. Both of these circles are to be considered as continually revolving. The stars, which successively appear in the Horizon south, are laid down on the outer circle, and those, which successively appear in the Horizon north, are laid down on the smallest circle. The *small broken lines*, which meet at the Pole of the Ecliptic, pass between the twelve signs; as they are now reckoned. These signs received their names from the Constellations of the Zodiack, and formerly occupied the same spaces. But on account of the Precession of the Equinoxes, they are removed 30 degrees to the west; so as to begin where the Ecliptic intercepts the Equator on the 20th of March. Hence the first sign, which is called *Aries* from the Ram, now includes the Fishes; and the Ram is in Taurus, the 2d sign. Each one of these twelve Constellations is about 30 degrees east of the sign which is named after

it. These small lines meet 23½ degrees from the north Pole, and the Ecliptic extends the same distance to the north and south of the Equator, because the Axis of the Earth is inclined toward the Plane of its Orbit; as you saw by Illustration, Lesson IV. The six first signs are called the northern signs because they are north of the Equator, and the rest southern.

The large lines which meet at the North Pole, are Meridians, 30 degrees apart. Every two of them includes a space equal to that through which the Sun seems daily to pass in two hours. Those at the right hand, are east; and those at the left, west. The dates affixed to them denote the time when the parts of the heavens which they represent, pass over the meridian of the place where you live at 8 o'clock in the evening. If it be earlier in the month than the time noted, or earlier in the evening than 8 o'clock, you must consider the line as a little to the east of you. If it be later you must consider it as a little to the west. For a line is to be considered as passing over head once in two hours, and arriving nearly four minutes sooner every evening, than it did the preceding evening.

The stars which are laid down on the circle of Latitude 42° N. will pass directly over head, if you live near that latitude. Two or three hundred miles north or south would occasion no material variation. Were you at that distance north, the stars would seem to be removed to the south; and in the same proportion your view would fall short of the outer circle of the Map,

and be extended beyond the smallest circle. The reverse would take place if you should travel south. But no distance east, or west, would occasion the least variation.

DIRECTIONS HOW TO USE THIS MAP.

In order to use this Map it is not necessary to know precisely the time of the evening, nor the day of the month. But any time, the fore part of the evening, view the stars over head, and north and south, down to the Horizon. Then trace the line for the month through the North Pole to the opposite side of the smallest circle. On and near this line you will see the stars you viewed, represented; the names that the ancients gave them, and the figures which designate the spaces they occupy. The lines at your right hand pass at the same time through the points where the Sun seems to be at 10, 8, and 6 o'clock in the forenoon; and those at the left hand pass where the Sun seems to be at 2, 4, and 6 o'clock, in the afternoon. From this circumstance you can easily find the stars which you see at the east and west, and determine what part of the Map is to be considered as below the Horizon. After you have found the names of two or three stars, you can readily find the rest by their relative situation.

DIRECTIONS FOR FINDING THE PLACES OF THE SUN, MOON, AND PLANETS BY THE MAP.

By the Ephemeris, and the Calendar pages of an Almanack, you can find in what signs the Sun, Moon, and Superior Planets are; and then find where these Signs are by the small broken lines on the Map. Or you may find their places by the following statements.

The Sun is always about 120 degrees west at 8 o'clock, P. M.; or 4 Signs west of the line, which passes overhead at that time. It passes through a Sign every month.

The Moon passes through all the Signs every month, and one of them in about 2½ days. It is in the same Sign with the Sun at its change.

Mercury is never as much as one Sign from the Sun.

Venus at its greatest Elongation is not more than 47 degrees and 48 minutes from the Sun—little more than a Sign and a half.

The Superior Planets move toward the East; though they sometimes appear to be stationary, or retrograde.

Mars passes through about six Signs a year. It is now, January 1st, 1826, in Libra.

Jupiter passes through a Sign every year. It is now in *Virgo*, near the Lion.

Saturn passes through a sign in about two years a half. It is now in *Gemini*, near the south Horn of the Bull and west of it, but will soon pass to the east of it, and appear near the Twins for two or three years.

Herschel passes through a Sign in seven years. It is now in *Capricorn.*

By remembering where these Planets are, and how fast they move toward the east, you may determine nearly, where they will be at any future time; so as to be able to find them. The Planets do not twinkle like the fixed stars; but shine with a steady light, like the Moon. They are always in the Constellations of the Zodiack. When about three Signs before or after the Sun their motion so corresponds with that of the Earth as that they appear stationary. When passing from one station to another through their opposition to the Sun their motion is retrograde, at other times it is direct or toward the east.

QUESTIONS.

What does this Map represent?

Where are the Stars laid down, which appear in the Horizon south? In the Horizon north? which pass overhead? Which never set?

Where do the small broken lines pass, which meet at the Pole of the Ecliptic?

How many Signs are there? From what did they receive their names?

Why do they not now occupy the same spaces with the Constellations which gave them their names?

What are the large dated lines, which meet at the N. Pole?

How would you find on the Map the stars which you see in the heavens?

How would you find the Sun's, Moon's and Planets' places by this Map?

LESSON XIII.

THE DISTANCE OF THE FIXED STARS.

Is not God in the height of heaven! and behold the height of the stars how high they are!—Job. xxii. 12.

The Solar System is separated by an immense space from all the surrounding stars. The distance of the Sun and Planets can be easily measured, and their magnitudes ascertained. But by no process can we determine the distance of even the nearest Fixed Stars. They seem diminished when viewed through a telescope which magnifies a Planet *two hundred times.* Though Herschel's telescope which magnifies more than six thousand times increases their *blaze*, it does not discover their *disk*, nor furnish any assistance for discovering their magnitudes or distance.

The diameter of the earth's Orbit bears no perceptible proportion to their distance. Hence, from a law of vision, it is certain that their distance is at least a hundred thousand times the extent of that diameter.

ILLUSTRATION.—View an object at the south; and as you walk towards the east it will seem to move towards the west, if it is not very remote. By observing how far it has removed, and how far you have walked, you can determine its distance by the rules of geometry. But if the direction, in which you view it, does not vary, you may be certain that it is vastly farther from you, than you have walked—a hundred thousand times farther, if no variation can be discovered by an accurate instrument.

But SIRIUS at the south, supposed to be the nearest Fixed Star, maintains precisely the same relative situation, it did six months ago; though since that time, we have moved to the east one hundred and ninety Millions of miles, or the whole diameter of the earth's Orbit. It is therefore at least *nineteen Billions* of miles from us; or a hundred thousand times *one hundred and ninety Millions* of miles. Lines drawn to it from the extremities of the Earth's Orbit would seem parallel, forming no angle. But if they did form a small angle, say two seconds of a degree, and a calculation were made accordingly, you would find it to be so far off, that a cannon ball, flying at the rate of *four hundred and eighty miles an hour*, would not reach it in *four Millions of years*. It is still farther than this—how much farther none can tell.

The Fixed Stars seem crowded together, especially the small ones, which compose the *Milky Way*, and other cloudy spots in the heavens. But each one of them is probably, as far from all the rest, as the nearest is from our Sun; and is itself a centre to a system, like the Solar System —a sun to revolving planets.

QUESTIONS.

How much can the Sun and Planets be magnified by a telescope?

How do the Fixed Stars appear, when viewed through such a telescope?

How long is the diameter of the earth's Orbit?

Does one hundred and ninety millions of miles bear

any perceptible proportion to the distance of the Fixed Stars?

What then is the least distance, at which we can consider them?

How long might a cannon ball fly at the rate of 480 miles an hour, and not reach them?

What are they supposed to be? and how far from one-another?

What causes that white tract called the Milky Way?

LESSON XIV.

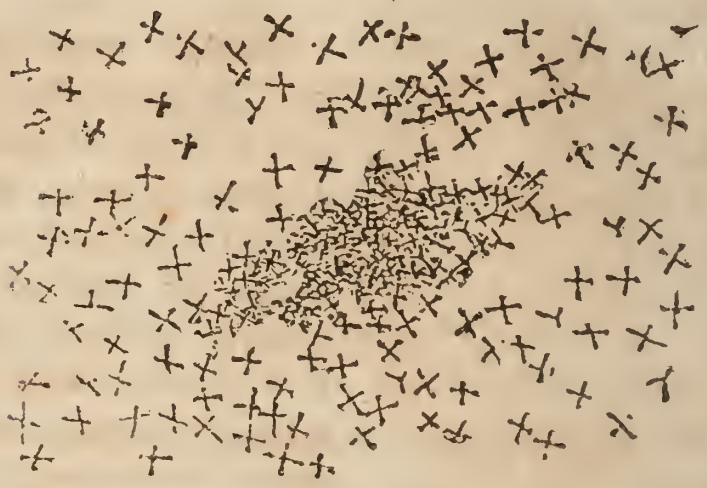
THE NUMBER OF FIXED STARS.

He telleth the number of the stars; he calleth them all by their names—Psalm cxlvii. 4.

The number of stars, visible to the naked eye, is small when compared with that, which a telescope presents to view. Every improvement of the telescope has discovered stars, not seen before, and numerous cloudy spots which seem to be stars, too remote to be distinctly visible. Hence the created universe seems to have no limits. God alone can tell the number of the stars. There are no bounds to space, nor to his creating power, and no reason appears why he should have so restricted the number of them, as that they could be computed by a finite mind.

The heavens seem to be filled with clusters of stars; and every cluster, is supposed to be an immense system of Solar Systems. The following Figures show how they appear when viewed with a telescope.

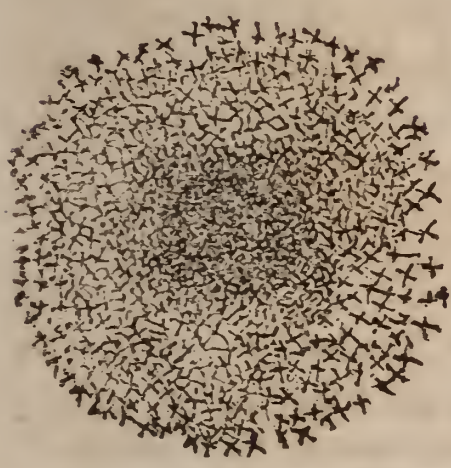
The following figure represents a COMPRESSED CLUSTER of STARS, the centre part 8′ long 2′ broad.



The following figure represents another similar CLUSTER of STARS.

NOTE.—The diameter of the Sun's disk is 32′ 15″. Hence the Sun appears vastly larger than the spaces, which these clusters occupy.

The following figure represents a GLOBULAR CLUSTER 2′ in diameter, as seen with Mr. Herschel's 40 feet telescope.



Should you, moving like an unbodied spirit, direct your course to the nearest Fixed Star, it would increase to your view, till you would see planets rolling round it. On approaching it, it would become a resplendent universe. This world and all our Planets would disappear; and the Sun itself become a mere point—a distant twinkling star. The same transition would take place, should you leave your new station for the next star; that star would increase, become a sun to revolving worlds, while the one you last left would dwindle into a point. It is probable you might thus proceed with the rapidity of lightning, and at no assignable period reach the bounds of creation.

We have seen that the bodies of the Solar System are kept in their places by their centripetal and centrifugal forces. Every other system of worlds is probably balanced in the same way. But the systems themselves, if limited, must be drawn together by their mutual attraction; unless prevented by a projectile force, giving them a tendency to revolve round a common centre.

QUESTIONS.

Who can count the number of the stars?

How is it probable that the stars would appear to you if you approached them?

Could a created spirit ever reach the bounds of the universe?

What prevents the systems of worlds from rushing together?

LESSON XV.

THE INHABITANTS OF THE WORLDS INNUMERABLE.

Dominion and fear are with him; he maketh peace in his high places. Is there any number of his armies?—Job xxv. 2.

The Planets are evidently calculated and designed to accommodate rational beings. They are all like this Earth, and some of them vastly larger. They have day and night, summer and winter. Three of them at least have moons to attend them. Many circumstances constrain us to believe that they are filled with inhabitants; and that every Fixed Star illuminates worlds peopled with creatures like ourselves, but not involved with us in rebellion against the Creator—that there is peace in all his high places.*

* Jehovah intimates that it would have been inconsistent for him to create the Earth, had he not designed it to be inhabited. *He created it not in vain, he formed it to be inhabited.* Isaiah xlv. 18. As he shows us a number of other worlds, and gives us reason to believe that a far greater number are enlightened by the myriads of suns, presented to our view, must we not infer from his perfections that he acted consistently in creating them, that he created them not in vain, but to be inhabited?

He informs us that *the morning stars sang together, and all the sons of God shouted for joy,* when he laid the foundations of this earth.* Hence intelligent creatures, and perhaps systems of worlds, previously existed. The declaration seems to intimate that the holy inhabitants of these early created worlds, as well as *the innumerable company of angels* rejoiced to see the new displays of power, wisdom, and goodness, their creator made in bringing this world into existence. At least, there is reason to think, that such inhabitants are included in his *numberless armies* among *the principalities and powers in heavenly places.*

The descendants of Adam are numerous beyond our conception. But they probably bear no greater proportion in this respect, to the other subjects of God's moral government, than a drop does to the ocean, or the smallest particle of dust to the whole earth. Were the Solar System with all its inhabitants struck out of existence, the loss would be comparatively no greater, than that of a single leaf in a boundless forest.

Every intelligent creature separately considered, is inconceivably valuable, in that he possesses immortal powers, and must exist in endlessly increasing bliss or woe, according to the character he forms while on trial. How immensely valuable then is the aggregate of the intelligent creation! But all are vanity when contrasted with the Creator. His powers, glory and happiness transcend theirs, as infinite space

* Job xxxviii. 7.

does a single point. *The Lord is high above all nations, and his glory above the Heavens:—Who humbleth himself to behold the things that are in the heaven and in the earth.** *All nations before him are as nothing; and they are counted to him less than nothing, and vanity.*† *Yea, the heavens are not clean in his sight. He put no trust in his servants, and his angels are charged with folly.*‡

QUESTIONS.

What reason is there to believe that the Planets are inhabited?

What evidence have we that intelligent creatures existed before men?

In what respect is every human being immensely valuable?

How do the human race compare with the rest of the intelligent creation?

How are all creatures esteemed in comparison with God?

What passages in the Bible represent him as infinitely exalted above creatures?

LESSON XVI.

THE CONDESCENSION OF GOD.

When I consider thy heavens, the work of thy fingers, the moon and the stars which thou hast ordained; what is man that thou art mindful of him, and the son of man that thou visitest him?—Psalm viii. 3.

The human race, though mean and worthless in comparison with the rest of the universe, are not unnoticed by their Creator. With all the

* Psalm cxiii. † Isaiah xl. 17. ‡ Job xv. 15. and iv. 18.

complicated and endlessly protracted concerns of creation devolving on him, he regards us individually as much, and is as attentive to our wants, as he would be, if he had no other charge. *Hast thou not known, hast thou not heard that the everlasting God, the Lord, the Creator of the ends of the earth fainteth not, neither is weary? there is no searching of his understanding.—He is good to all and his tender mercies are over all his works.**

But we have transgressed his holy law, on the honour of which the happiness of the universe depends. His benevolence therefore would have required that we should perish unless an adequate remedy were provided. For he could not otherwise pardon and save the guilty consistently with general justice. In this season of awful suspense his voice of mercy was heard—LIVE—I HAVE FOUND A RANSOM. *For God so loved the world that he gave his only begotten Son, that whosoever believeth in him should not perish, but have everlasting life.—Without controversy great is the mystery of Godliness: God was manifest in the flesh.* He who created and upholds all things by the word of his power—*who being in the form of God, thought it not robbery to be equal with God, took on him the form of a servant; and was made in the likeness of men,*† and passing by millions of other worlds, that needed no Saviour, he descended to this

* Isaiah xl. 28. Psalm cxlv. 9.

† John iii. 16. 1 Tim. iii. 16. Hebrews i. 2, 3. Phil. ii. 6.

globe, suffered, and died, to save the rebellious inhabitants, who deserved to die. Thus he selected this small obscure part of his dominions as a theatre for displaying his perfections in the greatest of all his works—the work of redeeming love—a work which in its result will outshine that of creation itself; and resplendently manifest his glory through the universe—*To the intent that now unto the principalities and powers in heavenly places might be known by the church the manifold wisdom of God.**

"The first archangel never saw
"So much of God before."

The Moon and Stars—the whole material and intellectual Creation is the effect of divine goodness. *The Lord hath made all things for himself——For his pleasure they are, and were created ;*† for the gratification of his infinite benevolence. He is full of compassion, ready to pardon, and save all who comply with his requisitions. But his word and Providence declare, that he will never relinquish his claims as the Moral Governor of the souls he has made ; nor bend his mighty movements to meet our puny plans. The worlds revolve, and the wheels of his Providence roll on, as the highest good of the universe requires ; and those who walk contrary to him must be crushed. If millions of men thus perish, the loss is as nothing, when contrasted with the interest of his vast and eternal empire ; and desirable, considered as essential to that in-

* Eph. iii. 10. † Prov. xvi. 4. Rev. iv 11.

terest. But yield your powers to his command, and you may then humbly call him your God, and view the heavenly bodies, as they roll, and say they are yours, since they belong to your "Father and your Friend;" and realize that he, who arranged them in such perfect order, and fixed the laws by which they are governed, has pledged his veracity for your eternal protection and support.

> "The voice that rolls the stars along,
> Speaks all the promises."

The visible creation loses all its splendour, when compared with the glories of the third heavens. It was brought into existence for a temporary purpose, and will cease when that purpose is answered; as the scaffold is removed when the building is finished. The Sun will shine, and the planets revolve, till the work of redemption is completed. *Then the heavens shall pass away with a great noise, and the elements shall melt with fervent heat; the earth also, and the works that are therein, shall be burnt up. Nevertheless we, according to his promise, look for new heavens and a new earth, wherein dwelleth righteousness.**

QUESTIONS.

Does God regard us amidst the immensity of his works?

In what way has he manifested peculiar regard for the human race?

*2 Peter iii. 10, 13.

Will other worlds be benefitted by his displays of grace on earth?

For what did God create all things?

Is it desirable that he should favor the guilty at the expense of the general good?

In what way can we secure his endless favor and protection?

What evidence have we that the visible heavens are doomed to destruction?

What is promised to the righteous in view of this awful catastrophe?

Repeat the passage of Scripture with which each Lesson begins.

GLOSSARY,

OR

EXPLANATION OF IMPORTANT TERMS

RELATING TO

ASTRONOMY.

Altitude, the height of a heavenly body above the Horizon, reckoned on a vertical circle.

Amplitude, the distance of a heavenly body, when rising or setting, from the east or west point in the Horizon.

Angle, the inclination of two lines meeting in a point. If one line be perpendicular to the other, the angle is 90° or a *right angle*.

Anomaly, a planet's distance from its aphelion.

Aphelion, that point in the orbit of a heavenly body which is farthest from the Sun. The Earth is in Aphelion in July, for it is then at its greatest distance from the Sun. At the same time the Sun is in Apogee. The Earth's Aphelion moves at the rate of 1° 43′ 35″. in a hundred years. This is called its *secular motion*.

Apogee, the Sun's or Moon's greatest distance from the Earth. The Moon's Apogee moves round her whole Orbit in about nine years. It is now in Aries. But in 1827 it will be in Gemini.

Area, the surface contained between any boundaries or lines. The Planets describe equal Areas in equal times. That is, straight lines, considered as drawn from them to the Sun, and moving as they move, pass over just as much space one day as another. Hence the nearer they are to the Sun, the faster they move; and the reverse.

Astronomy, a science that relates to heavenly bodies.

Attraction of Gravitation, the tendency which bodies have to approach one another without any apparent cause.

Axis, the imaginary line about which a globe or circle rolls.

Bissextile, (twice six) leap year, when a day is added to February, but when the Romans used to reckon the sixth day of the Calends of March twice over.

Central Forces, the composition of two forces, by which a body moves in a circle or curve. One force tending to draw it toward the centre, and the other to throw it forward, it can only move in a middle course between them, so as to describe a circle or curve.

Centrifugal Force, the force by which a revolving body tends to move forward in a straight line away from the centre.

Centripetal Force, the force which draws a revolving body toward the centre.

Conjunction. Two heavenly bodies are in conjunction when they are in the same longitude, or when they appear in the same direction.

Copernican System, the present system of Astronomy. It was taught by Pythagoras five hundred years before Christ, and revived in the sixteenth century by Copernicus.

Cycle of the Moon, or *the Golden Number*, is a revolution of nineteen years, when the Moon returns again to its same relative situation with respect to the Sun and signs. Its conjunctions, oppositions, and other aspects are within an hour and a half of being the same as they were on the same days of the month nineteen years before. The reason of this revolution is that the Sun attracts the Moon, when she is north or south of the Ecliptic, and causes her to return to it again sooner than she otherwise would.

Cycle of the Sun, a period of twenty-eight years, when the days of the month return to the same days of the week, and the Sun's place to the same degrees of the Ecliptic on the same months and days.

Day, (sidereal,) 23 h. 56 m. 6 sec. or one rotation of the Earth.

Day, (solar,) the time from noon to noon.

Day, (civil,) from midnight to midnight.* A day in the history of creation means light considered as divided into evening and morning. Or the time in which light from its eastern to its western extremity performed one revolution round the earth. "God called the light day." And the evening and the morning were the first day.

Declination, the distance of a heavenly body from the Equator. When the Sun declines 23° 28′ from the Equator, it meets a Tropic, and returns.

Degree, the three hundred and sixtieth part of a circle. Hence a degree is great or small according to the circle. A degree of a great circle of the Earth is sixty-nine miles. But a degree of longitude in latitude 42° is about fifty-one miles. For circles around the Earth parallel to the Equator, grow less and less toward the north and south Poles. Fifteen degrees in the heavens is about as far as the sun seems to move in an hour. For it is the twenty-fourth part of three hundred and sixty.

Diameter, a straight line extending through the middle of a circular figure or globe.

Digit, the twelfth part of the Sun's or Moon's diameter. The term is also applied to that part of the Earth's shadow, by which the Moon is eclipsed. If this be wider than the Moon the eclipse is more than twelve digits.

Disk, the face or apparent surface of a heavenly body.

Dominical Letter, one of the seven first letters of the alphabet, used for the purpose of showing on what day of the month the first Sabbath of the year falls.

Eccentricity, the distance between the real centre of an Ellipse and either of its Foci.

Ecliptic, a circle around the heavens in which the Sun seems to pass every year. It is called by this name because the Moon is always in or near the plane of it, at the time of an eclipse of the Sun or Moon.

Ellipse, is an oval figure or a circle so prolonged as to have two centres or foci. The Orbit of every Planet is an Ellipse having the Sun in one of its foci. Hence the

* A civil day is reckoned differently by different nations.

Planets are once in Perihelion and once in Aphelion during every revolution round the Sun. Their distance from the Sun, which is between these two extremes, is called their *mean distance*. Thus the *mean* distance of the Earth is ninety-five million of miles, because it is at that distance when half way between its Aphelion and Perihelion.

Elongation, the apparent distance of a Planet from the Sun.

Epact, the Moon's age at the end of the year; or the difference between the Lunar and Tropical year.

Ephemeris, an account of the daily motions of the Planets, with respect to the Signs.

Equinoxes, the beginning of Aries and Libra, where the Sun crosses the Equator.

Galaxy, the Milky Way, a white track in the heavens, occasioned by myriads of Stars too small to be distinctly seen.

Hemisphere, half a sphere or globe.

Latitude, the distance north or south of the Equator.

Latitude, (celestial,) the distance north or south from the Ecliptic. Hence a heavenly body north of the Equator is in south latitude, if it be on the south side of the Ecliptic.

Longitude, the distance east or west. Fifteen degrees of Longitude make an hour's difference in time. Thus, when it is noon here, it is one o'clock fifteen degrees east, and eleven o'clock fifteen degrees west, &c.

Longitude, (celestial,) the distance east from the first of Aries reckoned on the Ecliptic. Hence the last degree of Pisces is the three hundred and sixtieth degree east Longitude.

Horizon, (rational,) a circle which divides the Earth and Heavens into upper and lower hemispheres.

Horizon, (senseable,) the circle where the Heavens and Earth appear to meet.

Mean distance, time or motion, is that which is between the two extremes.

Meridian, a straight line passing from the north to the south pole. The Meridian of any particular place passes through the Zenith of that place. Thus the Sun is on our Meridian at noon. A Star is likewise on our Meridian,

though north of us, if it be directly between us and the pole.

Month, (Lunar,) 27 days, 7 h. 43 m. the time in which the Moon passes from a point in her Orbit to the same point again.

Month, or *Lunation*, 29 days, 12 h. 44 m. 3 seconds, or the time from one new moon to another.

Month, (Calendar,)

> Thirty days hath September,
> April, June and November.
> February has twenty-eight alone,
> All the rest have thirty-one.

Motion, (secular) is the progression which the Aphelion and Perihelion make in a hundred years. These points in the Earth's Orbit move in that time $1^{\circ}\ 43'\ 35''$. Hence they will perform a revolution round the Ecliptic in 20,700 years if the world should continue; and when half of that time is elapsed, the Sun will be in Perigee the first of July.

Nadir, the point under foot directly opposite to the Zenith.

Nebulæ, clusters of exceedingly small stars. Dr. Herschel with his mighty telescope has discovered more than two thousand of them. Each of these spots is probably as large as the Milky Way, which he supposes includes the Sun and all the Stars of the first, second and third magnitude.

Nodes, the two points in which the Orbit of the Moon or a Planet crosses the plane of the Ecliptic. The Moon is never more than five and a half degrees from the Ecliptic. Hence it runs high and low every month.

Nutation of the Poles. The Earth's Axis changes its inclination to the plane of the Ecliptic twice a year. Hence its Poles nod, or have a nutation. This is caused by the accumulation of matter about the Equator, which the Sun attracts when north and south of it. [See Lesson X.]

Opposition. When a heavenly body is 180° from the Sun, it is in opposition to it.

Parallax, the difference between the apparent direc-

tions of a heavenly body as seen from different stations.

Penumbra. The dark part of the Earth's Shadow is called its Umbra, and the light part its Penumbra.

Perigee, that point in which a heavenly body is nearest to the Earth. The Perigee of the Moon or a Planet is always six signs from its Apogee.

Perihelion, the point in the Orbit of a heavenly body which is nearest to the Sun. The Earth is in its Perihelion in January. At the same time the Sun is in its Perigee. Most of the Sun's rays, which reach the Earth in the winter, fall to the south of us, and the rest strike us obliquely. Hence it is colder than in the Summer, though the Sun is nearer to the Earth.

Periodical Time, is the time in which a planet performs its revolution round the Sun. The squares of the Periodical times of the Planets are as the cubes of their mean distances from the Sun. From this law the relative distances of the Planets have long been known. Hence it was only necessary to find the distance of one of them in order to find the distance of the rest. By the transit of Venus over the Sun in A. D. 1761 and 1769, the distance of that Planet was ascertained. From that the distances of the other Planets have been accurately calculated.

Plane. The Plane of a circle or an ellipse is its imaginary surface. The Plane of the ecliptic or the Earth's Orbit is considered as indefinitely extended. It not only passes from the Sun through the Earth, but it extends to the fixed Stars. Bodies directly over or under the Earth's Orbit are in its plane, however distant.

Poles, the extremities of the Axis. The Poles of the Ecliptic are 23° 28′ from those of the Equator or the Earth; for the Axis of the Earth is inclined toward the Plane of the Ecliptic. This inclination is diminishing at the rate of fifty seconds of a degree in a hundred years.

Refraction. Rays of light are refracted, or bent out of their course, when they enter obliquely from a rarer into a denser medium. This is the reason that heavenly bodies near the horizon appear higher than they are in reality.

Retrograde, the motion which planets sometimes appear to have toward the west contrary to the order of the

signs, and contrary to the course in which they really move. This appearance is occasioned by the revolution of the Earth.

Revolution. A body is said to revolve or perform a revolution when it moves once round its Orbit. The rotation of the Earth is sometimes called its daily revolution.

Right Ascension of a heavenly body is the distance of its meridian from the first of Aries.

Roman Indiction, a period of fifteen years, adopted by the Romans for civil purposes. This number multiplied by that of the Solar and Lunar Cycles makes seven thousand nine hundred and eighty years, or the JULIAN PERIOD. This period is considered as having commenced seven hundred and nine years before creation.

Rotation, the rolling of a globe on its axis.

Sign, the twelfth part of the Zodiack.

Sizygies, those points in the Moon's Orbit where she is when new and full.

Solstices, two points in the Ecliptic at its greatest distances from the Equator. One is in Cancer, where the Sun is the 21st of June ; the other is in Capricorn, where the Sun is the 22d of December. Two circles passing through these points, parallel to the Equator, and 23° 28′ from it, are called Tropics. Their planes include the Torrid Zone.

Shooting Stars. They are generally supposed to be ignited exhalations. But the Lon. Mon. Mag. (See Conn. Obs. Sept. 6) represents them to be globes, revolving round the Earth in elliptical Orbits, like Comets round the Sun ; and that when they enter the atmosphere they shine, because they are heated by resistance and friction. It is certain that the Earth has such balls revolving round it ; and that they, from some cause, become heated, and throw off large stones by explosion. A stone, which fell from one of them a few years ago, is to be seen at Yale College.

Year, (Lunar,) 12 Lunations, or 354 days, 8 h. 48 m. 36s.

Year, (Periodical,) 365 days, 6 h. 9 m. 14½ s. the time in which the earth completes a revolution in its orbit.

Year, (Tropical,) 365 days, 5 h. 49 m. the time in which the Sun passes from a Tropic to the same Tropic again. This is the true year. It is about 20¼ minutes less than the Earth's periodical time, because the Sun after leaving an Equinox or Tropic returns to it again, while the earth has not got round its Orbit by 50 seconds of a degree. This causes the Precession of the Equinoxes. (See Lesson X.)

Year, (Julian or Civil,) 365 days, 6 h. The year thus fixed by Julius Cæsar is 11 minutes too long. Hence in the course of ages the days of the month varied with respect to the Equinoxes and Tropics. To correct this variation, and prevent it for the future, the New Style was introduced, and arrangement made for omitting the Bissextile day at the commencement of three centuries out of four.

Zenith, the point over head.

On the Map of the heavens, your *Zenith* is the same as your *Latitude*. Around this point, as a centre, place a ring made of pasteboard or paper, equal to the Equator, and it will represent your *Horizon*. Turn the Map round to the left under the ring, as on a pivot at the N. Pole, and you will see how the heavens come successively to view every day. While the heavens turn round, as thus represented, your Zenith, considered as fixed in the centre of the Horizon, makes an imaginary circle round the Pole, like that on the Map at Latitude 42°. Let the Zenith be at the Equator, and the ring will extend beyond this Map. For there the north and south Poles, are both in the Horizon; and all the heavens rise and set every day. The farther your Zenith is north of the Equator, the more stars at the south will be always below your Horizon; and the more at the north, will be always above it. This you can illustrate by placing the ring so that different degrees of latitude, may be successively in its centre. If the north Pole be its Zenith, it will coincide with the Equator; and all the included stars will revolve and never set. By thus placing the ring round the Pole, you will see why the sun never sets there, when it is in the northern signs; and why it never rises there, when in the southern signs. Let a meredian of the Map be the diameter of the ring, and

your latitude its centre, and you will see what stars are rising and setting at the time denoted by the date. Turn the Map, to the right, four signs, and you will see where the sun is at that time, and what part of the heavens was in your Horizon, eight hours before, or at noon.

Zodiack, a space round the heavens, extending 8° each side of the Ecliptic. This space includes the Signs, and the Orbits of all the Planets.

CORRECTION.

Omit the last sentence in 28th page, and read, thus:—"The Moon in its monthly course runs *high* when in Cancer, and *low* when in Capricorn. It runs unusually high and low when its *Ascending* Node is in Aries; for then its greatest latitude is north of the summer solstice, and south of the winter solstice. But nine years afterward, when its *Descending* Node comes round to Aries, it does not run so high and low by ten degrees. Thus it is continually varying toward the north or south with respect to the same signs.

There is a point between the Moon and Earth, at which their attractive influence is equal. Round this point, as a common centre, they both revolve every month. To illustrate this, run one end of a rod into a great apple, and the other end into a small one; and then make it turn round on a pivot, placed under it at the point where they exactly balance each other.

For several hours before the full, change, or quarters of the Moon, clouds usually collect or appear in commotion, and a storm frequently follows; especially when these alterations in the Moon occur between 2 o'clock A. M. and 2 o'clock P. M. Hence there may be a succession of stormy Sabbaths in the months of May and October this year, and once within four or five months every year. A lunar Equinoctial storm often occurs, when the Moon crosses the Equator, or enters Aries or Libra.

Page 45—48° for 84°.

Page 46—Vega for Viga.

Page 47—Equuleus for Equauleus.

Page 57—last paragraph, *and* before *a half*.

Page 50—for Feb. 12 and 20, read Feb. 1 and 2

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RECOMMENDATIONS.

Having heard read a part of a manuscript, containing a brief and familiar view of some of the elements of Astronomy, by the Rev. Amos Pettengill; I think that the statements and illustrations are substantially correct, and fitted to give valuable information to those who have not time or opportunity to read more extended treatises of Astronomy.

JEREMIAH DAY,
President of Yale College.

Yale College, July 27, 1825.

The proposed publication of Familiar Lessons on Astronomy, by Rev. Amos Pettengill, appears to me, considered as an introduction to the study of this entertaining and useful science, well adapted to this design, and to lead the mind to profitable contemplation of the works of the Creator.

NATH'L. W. TAYLOR,
Dwight Prof. of Didactic Theology in Yale College.

Yale College, 28th July, 1825.

Having cursorily looked over the "Familiar Lessons," above-mentioned, I concur with Professor Taylor in his favourable opinion of its merits.

CLAUDIUS HERRICK.

New-Haven, July 28, 1825.

Having seen a manuscript, entitled "A View of the Heavens, or Familiar Lessons," &c. by the Rev. Amos Pettengill, I am free to express my opinion in favour of its publication; and my belief that it will be highly useful as a school book.

JOSHUA BATES,
Pres. of Middlebury College.

Middlebury College, August, 1825.

Having cursorily examined the Rev. Amos Pettengill's "*View of the Heavens*, or *Familiar Lessons*," &c. I regard the design of his work a happy one, and the execution of it judicious; and do not hesitate to recommend it as a valuable assistant to parents and instructors in impressing upon the minds of youth the elements of the sublime and interesting science of Astronomy. I should be pleas-

ed to see it in the possession of every family in our country.

ABSALOM PETERS.

Bennington, Vt. Aug. 12, 1825.

I cheerfully concur in the sentiments expressed above.

S. R. ARMS.

Grafton, Vt. Aug. 25, 1825.

Having examined to some extent the Rev. A. Pettengill's "View of the Heavens," I fully concur in the recommendation given to it above.

REUBEN S. HAZEN.

West-Springfield, (Mass.) Aug. 31, 1825.

Having heard read parts of "Familiar Lessons on Astronomy," by Rev. Amos Pettengill, I have no hesitation in expressing my satisfaction with the work; fully believing it will prove a valuable introduction to the study of Astronomy. I sincerely wish its publication.

BENJAMIN RICE.

Deerfield, (Mass.) Aug. 30, 1825.

Having heard read the principal parts of the Rev. Amos Pettengill's Familiar Lessons on Astronomy: the plan of the work I regard as judicious, and would cheerfully recommend it as well adapted to give important information on the subjects of which it treats. I should be happy to see it in general circulation.

JONA. M'GEE.

Brattleboro', Aug. 29, 1825.

In addition to the foregoing, the following persons, being ministers of the Gospel, in connection with the author, having examined the Treatise on Astronomy, have expressed their decided approbation and cordial recommendation of the work.

Rev. Mr. CONE, Bristol.
Rev. Mr. WOOD, Cheshire,
Rev. Mr. HART, Plymouth.
Rev. Mr. GRISWOLD, Watertown.
Rev. Mr. CRANE, Waterbury.
Rev. Mr. PRENTISE, Canaan.
Rev. Mr. CAMP, Northfield.

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